MATH-642 **Artificial Life**

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Cursus	Sem.	Type
Mathematics		Opt.

Contact language	English
Credits	2
Session	
Exam	Oral presentation
Workload	60h
Hours	**34**
Lecture	22
Practical work	12
Number of positions	

Frequency

Every year

Remark

Spring semester

Summary

We will study the emergence of life-like phenomena, such as locomotion, resilience,, reproduction, and evolution in mathematical models, in particular in discrete and continuous cellular automata, developing techniques to analyze, connect and characterize life-like features in such systems.

Content

This course aims at giving mathematically relevant ideas and tools to understand the emergence life-like behaviors in various media. In particular, we will cover the following topics (plus some other ones, depending on the audience's interest).
- What is life, goal of alife, strong vs weak alife positions.
- Central examples: the game of life: zoology of objects, theorems and open problems; Von Neumann's self-reproducing machine, Codd's simplification, Langton's loop; Turing's reaction-diffusion models; quines; KdV Equation; Smooth Life and Lenia.
- Discrete cellular automata: basic theorems on cellular automata (reversibility, locality, Turing completeness); rule space; zoology, Wolfram's classification, lattice-gas models.
- Continuous cellular automata: coupled map lattices, reaction-diffusion models, pattern formation, discretizations, zoology, bifurcations, intermittency, solitons, chaos, neural cellular automata.
- Computational theory: Turing machines, quines and the Kleene's fixed point theorem, applications to self-reproduction, program/hardware tradeoff, Turing completeness in discrete and continuous media.
- Soliton theory: examples, scattering transforms, Lax pairs, conservation laws, PDE instabilities.
- Consensus algorithms as living mechanisms: Nakamoto and other Byzantine-Fault-Tolerant consensus.
- Genetic information: mathematical models; evolution, mutation, and selection; error correction;genetic algorithms; error threshold and Eigen's paradox.

Keywords

Alife, cellular automata, self-reproduction, computational theory, solitons, gliders, game of life, statistical mechanics, consensus mechanisms